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A Description on the Second Dataset of the U.S. Army Research Laboratory Force Protection Surveillance System

by Alex L. Chan

ARL-MR-0670 **August 2007**

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14. ABSTRACT

This memorandum report provides a concise description on the second set of moving target image data, collected by the Image Processing Branch (AMSRD-ARL-SE-SE) of the U.S. Army Research Laboratory (ARL), for a force protection project. We describe the sensor and setting of this data collection effort, the purpose and content of this dataset, as well as the ground-truthing tool developed and used for this dataset. With these detail descriptions, we hope a reader may be able to understand the ARL force protection surveillance system (FPSS) datasets and the associated ground-truth information easily and to use them for his or her project readily.

15. SUBJECT TERMS
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1. Introduction

As a part of the research project on the force protection surveillance system (FPSS) at the U.S. Army Research Laboratory (ARL), a number of video sequences were collected at the Adelphi Laboratory Center (ALC) of ARL to aid the FPSS development efforts. To achieve a generic representation of typical FPSS scenarios, while avoiding specific details pertaining to ALC infrastructures, all image sequences in this dataset were taken from the roof of a 4-story building and focused on the main parking lot in the direction of a public road. No permanent buildings or other significant infrastructures in ALC were captured in these sequences. People and vehicles were the primary moving objects selected in this data collection effort. Due to significant distances and thermal signal properties, no facial identity of any human target or license plate number of any vehicle can be recognized in these sequences.

The first 85 selected image sequences of this data collection effort, which are collectively referred to as the "First ARL FPSS Dataset," have been documented in an ARL Memorandum Report entitled "A Description on the ARL Force Protection Surveillance System Data Set" (ARL-MR-600), and published in October 2004 by the same author. The image sequences in the first dataset were captured by a number of long-wave infrared (LWIR) cameras and color charge-coupled device (CCD) cameras across different times of the day and different seasons of the year. In other words, the variability within the first dataset was relatively high due to significant differences in the equipment used and the background observed. In the concluding section of that Memorandum Report, it was stated that the usefulness of the dataset would be greatly increased if the ground-truth information of the legitimate moving targets could be extracted and used. Fortunately, such ground-truth information has since been manually extracted from those sequences, and these ground-truth files are now available to the users of that dataset.

While the First ARL FPSS Dataset provided a variety of video data that was differentiated by the types of sensors, times of day, seasons of the year, and field-of-views (FOVs), none of the recorded activities were purposely staged to represent one or more suspicious activities or behaviors that would be of interest to typical force protection and security surveillance personnel. In other words, the first dataset does not provide examples of those rare, but possible suspicious scenarios, that an intelligent force protection surveillance system should be designed to recognize and act upon in real-time. Additionally, none of the scenarios were recorded concurrently by both color and forward looking infrared (FLIR) cameras; therefore, they were unable to support any research on multi-sensor detection and tracking.

For these reasons, the Second ARL FPSS Dataset was subsequently planned and collected. All the video sequences in the second dataset were collected using the Thermal Vision Sentry Personnel Observation Device (POD) manufactured by FLIR Systems, which is shown in figure 1. This Sentry POD consists of a LWIR uncooled microbolometer and a color visual

camera, which are bore-sighted and integrated in a sealed enclosure. The microbolometer has a focal plane array (FPA) resolution of 320 × 240 pixels and a spectral response at the wavelengths of 7.5 to 13 microns. To adequately capture the staged activities around the parking lot, the wider FOV of this microbolometer, 24° by 18°, was used throughout the second data collection effort. The color visual camera has a quarter-inch color CCD, which is capable of producing 460 National Television Standards Committee (NTSC) TV lines and zooming between 2.7° and 48°. The FOV of the color camera was adjusted to about 24°, so that the resulting color and FLIR images could be co-registered to an acceptable level. All scenarios were simultaneously captured by both cameras and stored in two separate digital video recorders (DVRs).

Figure 1. Sentry POD manufactured by FLIR Systems.

2. Dataset

In the Second ARL FPSS Dataset, most of the scenarios were actively staged by collaborators to represent a variety of suspicious activities and behaviors in the eyes of force protection and security surveillance experts. These video data were collected between November 2004 and January 2005 around a parking lot at ALC. There are 53 pairs of color-FLIR image sequences,

totaling 71,236 image frames and occupying 3.2 GB of disk space, in this dataset. A global linear transformation method was used to co-register each image pair to an acceptable level and scale the registered images to a common size of 640 × 480 pixels. All images are stored in JPEG format to achieve a good trade-off between image qualities and file size. The name, image type, storage size, and number of frames of each sequence are listed in table 1.

Table 1. Listing of 53 pairs of color-FLIR image sequences in the Second ARL FPSS Dataset.

Name of Sequence	Type of Imagery	Data Size of Sequence (kB)	Number of Frames
rf20041120_161701fc	Color	47536	990
rf20041120_161701fi	LWIR	27736	990
rf20041216_143701fc	Color	63400	990
rf20041216_143701fi	LWIR	43576	990
rf20041216_144100fc	Color	63376	990
rf20041216_144100fi	LWIR	43576	990
rf20041216_144230fc	Color	63376	990
rf20041216_144230fi	LWIR	43576	990
rf20041216_144442fc	Color	63376	990
rf20041216_144442fi	LWIR	43576	990
rf20041216_144715fc	Color	63376	990
rf20041216_144715fi	LWIR	43576	990
rf20041216_145010fc	Color	63376	990
rf20041216_145010fi	LWIR	43576	990
rf20041216_145145fc	Color	63376	990
rf20041216_145145fi	LWIR	43576	990
rf20041216_145855fc	Color	65244	990
rf20041216_145855fi	LWIR	43576	990
rf20041216_150031fc	Color	31448	490
rf20041216_150031fi	LWIR	21568	490
rf20041216_150427fc	Color	38048	590
rf20041216_150427fi	LWIR	25972	590
rf20041216_150612fc	Color	12664	190
rf20041216_150612fi	LWIR	8364	190
rf20041216_150734fc	Color	29620	440
rf20041216_150734fi	LWIR	19368	440
rf20041216_151520fc	Color	47372	740
rf20041216_151520fi	LWIR	32572	740
rf20041217_132617fc	Color	63376	990
rf20041217_132617fi	LWIR	44068	990
rf20041217_132750fc	Color	63376	990
rf20041217_132750fi	LWIR	44560	990
rf20041217_133143fc	Color	63376	990
rf20041217_133143fi	LWIR	43640	990
rf20041217_133458fc	Color	63376	990
rf20041217_133458fi	LWIR	46028	990
rf20041217_133718fc	Color	28168	440

Name of Sequence	Type of Imagery	Data Size of Sequence (kB)	Number of Frames
rf20041217_133718fi	LWIR	20016	440
rf20041217_133858fc	Color	31368	490
rf20041217_133858fi	LWIR	21568	490
rf20050110_172124fc	Color	10564	240
rf20050110_172124fi	LWIR	6724	240
rf20050110_172252fc	Color	8364	190
rf20050110_172252fi	LWIR	5324	190
rf20050110_172434fc	Color	23704	590
rf20050110_172434fi	LWIR	16532	590
rf20050110_172604fc	Color	7900	190
rf20050110_172604fi	LWIR	5080	190
rf20050110_172750fc	Color	13648	310
rf20050110_172750fi	LWIR	8688	310
rf20050110_172844fc	Color	14244	340
rf20050110_172844fi	LWIR	9528	340
rf20050110_173000fc	Color	8092	190
rf20050110_173000fi	LWIR	5324	190
rf20050111_160600fc	Color	42732	890
rf20050111_160600fi	LWIR	22808	890
rf20050111_160815fc	Color	47536	990
rf20050111_160815fi	LWIR	24156	990
rf20050111_161040fc	Color	47536	990
rf20050111_161040fi	LWIR	25200	990
rf20050111_161210fc	Color	13928	290
rf20050111_161210fi	LWIR	6968	290
rf20050112_111019fc	Color	42696	970
rf20050112_111019fi	LWIR	27408	970
rf20050112_111205fc	Color	19368	440
rf20050112_111205fi	LWIR	12468	440
rf20050112_111350fc	Color	43576	990
rf20050112_111350fi	LWIR	28676	990
rf20050112_112007fc	Color	39176	890
rf20050112_112007fi	LWIR	28188	890
rf20050112_112255fc	Color	12768	290
rf20050112_112255fi	LWIR	8128	290
rf20050112_112338fc	Color	13648	310
rf20050112_112338fi	LWIR	8696	310
rf20050113_095431fc	Color	47536	990
rf20050113_095431fi	LWIR	27724	990
rf20050113_095601fc	Color	28332	590
rf20050113_095601fi	LWIR	16528	590
rf20050113_104347fc	Color	39616	990
rf20050113_104347fi	LWIR	27736	990
rf20050113_104555fc	Color	25612	640
rf20050113_104555fi	LWIR	18044	640
rf20050113_104815fc	Color	29532	738

Name of Sequence	Type of Imagery	Data Size of Sequence (kB)	Number of Frames
rf20050113_104815fi	LWIR	21636	738
rf20050113_105900fc	Color	12008	300
rf20050113_105900fi	LWIR	8408	300
rf20050113_110120fc	Color	9604	240
rf20050113_110120fi	LWIR	6724	240
rf20050113_110246fc	Color	28412	710
rf20050113_110246fi	LWIR	19892	710
rf20050113_125815fc	Color	17608	440
rf20050113_125815fi	LWIR	12328	440
rf20050113_130001fc	Color	17608	440
rf20050113_130001fi	LWIR	12328	440
rf20050113_130320fc	Color	5604	140
rf20050113_130320fi	LWIR	4048	140
rf20050114_163232fc	Color	55456	990
rf20050114_163232fi	LWIR	35576	990
rf20050114_163442fc	Color	49856	890
rf20050114_163442fi	LWIR	32056	890
rf20050114_163600fc	Color	49856	890
rf20050114_163600fi	LWIR	32056	890
rf20050114_163720fc	Color	38652	690
rf20050114_163720fi	LWIR	24852	690
rf20050115_120400fc	Color	25976	590
rf20050115_120400fi	LWIR	21128	590
Total		**3,194,404**	**71,236**

The numerical part of the sequence name identifies the date and time of the first frame of the sequence. For example, the first frame of rf20041120_161701fc was recorded at 16:17:01 h on November 20, 2004. Because all the sequences in this dataset were recorded at the rate of 10 frames per s, the last frame of this 990-frame sequence was recorded 99 s after the first frame. The last character of the sequence name signifies the type of sensor that produced the sequence, where “c” and “i” indicates the “color” and the “LWIR” sensor type, respectively. To comply with the naming scheme of the first dataset, the “rf” at the beginning of each sequence name indicates that this sequence was collected from the roof top of a building, while the “f” near the end of the sequence name indicates that the sensor was made by FLIR Systems.

The length of each sequence, which varies between 140 and 990 frames, was dictated by the duration of a given activity and the 1,000-frame limit of the DVR during the retrieval of the video data. Six long-running activities were split into two consecutive sequences, while the longest scenario was split into three consecutive sequences due to the limitations of our DVR. Obviously, the number of color frames and the number of FLIR frames should be the same for a given sequence. However, the file size of a FLIR JPEG image is usually smaller than that of its color counterpart, primarily due to reduced color dimension and scene complexity. Figure 2 and figure 3 show a pair of color LWIR frames from rf20050110_173000fc and

rf20050110_173000fi, respectively. These images were linearly extracted and scaled in a way that most of the corresponding objects in the images are nearly co-registered. The co-registration is not perfect because of the different optical characteristics of the camera lens. For example, the light post near the upper-left corner of the color image appears to be slanting leftward, while standing perfectly upright in the corresponding FLIR image.

Figure 2. Color image from the rf20050110_173000fc sequence.

Figure 3. LWIR image from the rf20050110_173000fi sequence.

Instead of producing calibrated pixel intensities that are consistently tied to the actual surface temperature of the scene observed, the Sentry POD constantly stretches the observed thermal profile across its intensity spectrum to maximize the contrast of the imagery outputs. Due to this automatic gain control function of the Sentry POD, the resulting LWIR signatures for a constant-temperature object, such as a human, may change based on the background temperature of different scenes. All the scenarios in the Second ARL FPSS Dataset were collected during the winter of 2004, so humans appear consistently brighter than the background.

With three exceptions, every video sequence in this dataset contains a suspicious activity that was purposely staged. In addition to the staged activity, there were also non-staged activities created by passerby persons and vehicles in 35 of the 50 sequences. Among the three exceptions that do not have a staged activity, rf20041216_150612 and rf20050112_111205 exhibit some non-staged activities that match the general characteristics of this dataset; therefore, they were included in this dataset. In rf20050115_120400, there was no observable activity captured in this scenario, and it was included solely to provide a background reference to the preceding scenarios that were taken under the same FOV. In table 2, we provide the content description for each and every pair of image sequences and describe not only the staged activity involved, but also the non-staged activities whenever applicable.

Table 2. Content descriptions of the sequences in the Second ARL FPSS Dataset.

Name of Sequence	Description of Content
rf20041120_161701	2 people carry a box to a car in an empty parking lot, leave for a while, then return and put the box into the car, on a Saturday.
rf20041216_143701	3 people carry a box and load it into a van in a filled parking lot. Non-staged: 4 people and 4 cars move in the foreground.
rf20041216_144100	3 people walk to a van and open its tailgate. Non-staged: 3 people and 2 cars move in the foreground. Part 1 of 2.
rf20041216_144230	3 people remove a box from van and carry it away. Non-staged: 1 person and 2 cars move in the foreground. Part 2 of 2.
rf20041216_144442	3 people carry a box and leave it near a hydrant. Non-staged: 3 people move in the foreground.
rf20041216_144715	3 people come and remove a box near a hydrant. Non-staged: 2 people and 6 cars move in the foreground.
rf20041216_145010	3 people come and loiter around vehicles. Non-staged: 4 people and 1 car move in the foreground. Part 1 of 2.
rf20041216_145145	3 people loiter around vehicles and leave. Non-staged: 2 people and 3 cars move in the foreground. Part 2 of 2.
rf20041216_145855	3 people walk in the wooded area. Non-staged: 5 people and 5 cars move in the foreground. Part 1 of 2.
rf20041216_150031	3 people walk out of the wooded area. Non-staged: 2 people and 3 cars move in the foreground. Part 2 of 2.
rf20041216_150427	A van pulls to the curb, 2 people run to it and depart with the van. Non-staged: 3 people and 4 cars move in the foreground.
rf20041216_150612	1 person runs across parking lot, 1 person and 1 car also move in the foreground. Non-staged: This is not a planned event.
rf20041216_150734	A van pulls to the curb, 2 people get out of it, and all leave the scene later. Non-staged: 1 person and 1 car move in the foreground.
rf20041216_151520	A car pulls to the curb; another van comes and stops next to it for a while, both vehicles leave afterward. Non-staged: 2 people and 1 car move in the foreground.
rf20041217_132617	1 person comes and takes note at the curb. Non-staged: 3 people and 1 truck move in the foreground. Part 1 of 2.
rf20041217_132750	1 person takes note at the curb and leaves. Non-staged: 3 people and 2 cars move in the foreground. Part 2 of 2.
rf20041217_133143	1 car stops at curb for a while and drives away. Non-staged: 2 cars move in the foreground. Part 1 of 2.
rf20041217_133458	The same car stops at curb again and drives away. Non-staged: 2 people and 3 cars move in the foreground. Part 2 of 2.
rf20041217_133718	1 person leaves a bag near the curb and walks away. Non-staged: 1 car moves in the foreground.
rf20041217_133858	1 person picks up a bag near the curb and walks away. Non-staged: 2 cars move in the foreground.
rf20050110_172124	1 person leaves a bag in front of trash box and walks away. No other movement observed.
rf20050110_172252	1 person picks up a bag in front of trash box and walks away. Non-staged: 1 person moves in the foreground.
rf20050110_172434	1 person leaves a bag behind trash box and walks away. Non-staged: 3 people move in the foreground.
rf20050110_172604	1 person picks up a bag behind trash box and walks away. No other movement observed.

Name of Sequence	Description of Content
rf20050110_172750	1 person puts a bag under a car. Non-staged: 1 car moves in the foreground.
rf20050110_172844	1 person removes a bag from under a car. No other movement observed.
rf20050110_173000	1 person walks past behind a trash can with a bag, but does not leave it there. No other movement observed.
rf20050111_160600	1 car stops at trash can for a while and then leaves. Non-staged: 2 people move in the foreground.
rf20050111_160815	1 car comes and parks in parking spot for a while, and then leaves. No other significant movement observed.
rf20050111_161040	1 car parks in parking spot, the person exits the car after a while. Non-staged: 3 people move in the foreground. Part 1 or 2.
rf20050111_161210	1 car parks in parking spot, the person exits and walks away from the car. Non-staged: 2 people move in the foreground. Part 2 or 2.
rf20050112_111019	1 person comes and takes notes near the curb, then walks away. No other movement observed.
rf20050112_111205	Non-staged: 1 person walks and gets into a pickup truck, and then drives away. Not a planned event. No other movement observed.
rf20050112_111350	1 person loiters and take notes near the corner of parking lot. Non-staged: 1 person and 2 cars move in the foreground.
rf20050112_112007	A car comes and parks on a parking space, 1 person leaves the car, loiters around the curb, returns to car and drives away. No other movement observed.
rf20050112_112255	A car comes and parks on a parking space, 1 person leaves the car in a hurry. No other movement observed.
rf20050112_112338	1 person runs to parked car and drives away quickly. No other movement observed.
rf20050113_095431	1 person comes and stretches extensively near the curb. No other movement observed. Part 1 of 2.
rf20050113_095601	1 person stretches extensively near the curb and then leaves. Non-staged: 1 person moves in the foreground. Part 2 of 2.
rf20050113_104347	1 person jogs and stretches on the sidewalk, then leaves. Non-staged: 1 car moves in the foreground.
rf20050113_104555	1 person climbs up the earth bank near a pole from the sidewalk to the parking lot and leaves. No other movement observed.
Rf20050113_104815	1 person climbs up the earth bank near a pole from the road to the parking lot and walks away. Non-staged: 1 person moves in the foreground.
rf20050113_105900	1 person climbs up the earth bank at a closer range from the sidewalk to the parking lot and walks across it. No other movement observed.
rf20050113_110120	1 person walks up the sidewalk. Non-staged: 1 truck moves in the foreground.
rf20050113_110246	1 person walks on sidewalk, climbs up the earth bank at a closer range and walks across the parking lot. Non-staged: 1 car moves in the foreground.
rf20050113_125815	1 car stops along the earth bank beside a parking lot for a while, no one gets out of the car, and then the car leaves the scene. No other movement observed.
rf20050113_130001	1 car stops along the earth bank beside a parking lot, a man gets out of the car, quickly climbs up the earth bank, hides between the cars parked in the parking lot, rushes back into the waiting car, and then the car leaves the scene. No other movement observed.
rf20050113_130320	The same car above drives along road near earth bank without stopping. No other movement observed.

Name of Sequence	Description of Content
rf20050114_163232	1 person walks to his car in the parking lot and drives away. Non-staged: 2 people and 1 car move in the foreground.
rf20050114_163442	1 car comes and parks at the end of the parking lot, 1 person gets out and walks on the gravel road around some trailer offices. Non-staged: 2 people and 2 cars move in the foreground. Part 1 of 3.
rf20050114_163600	1 person walks on the gravel road and around the trailer offices, and then walks back to his car. Non-staged: 4 people and 6 cars move in the foreground. Part 2 of 3.
rf20050114_163720	The person above drives his car away from the parking lot. Non-staged: 2 people and 4 cars move in the foreground. Part 3 of 3.
rf20050115_120400	The same view as in the scenarios above on a quiet Saturday. Only one SUV parks in the parking lot. No movement observed.

3. Ground-Truthing Process

Carefully collected, selected, and co-registered video data are essential to the development of moving target indication algorithms. However, it is difficult to measure the performance of these moving target detection and tracking algorithms without reliable ground-truth information associated with the image sequences. For this reason, we have identified the location and target type of all moving objects on each and every image frame in both the First and Second ARL FPSS Datasets. Given the huge number of image frames in these two datasets, we developed a simple but useful graphical user interface (GUI) to facilitate the ground-truthing effort. The resulting ARL FPSS ground-truthing GUI is shown in figure 4.

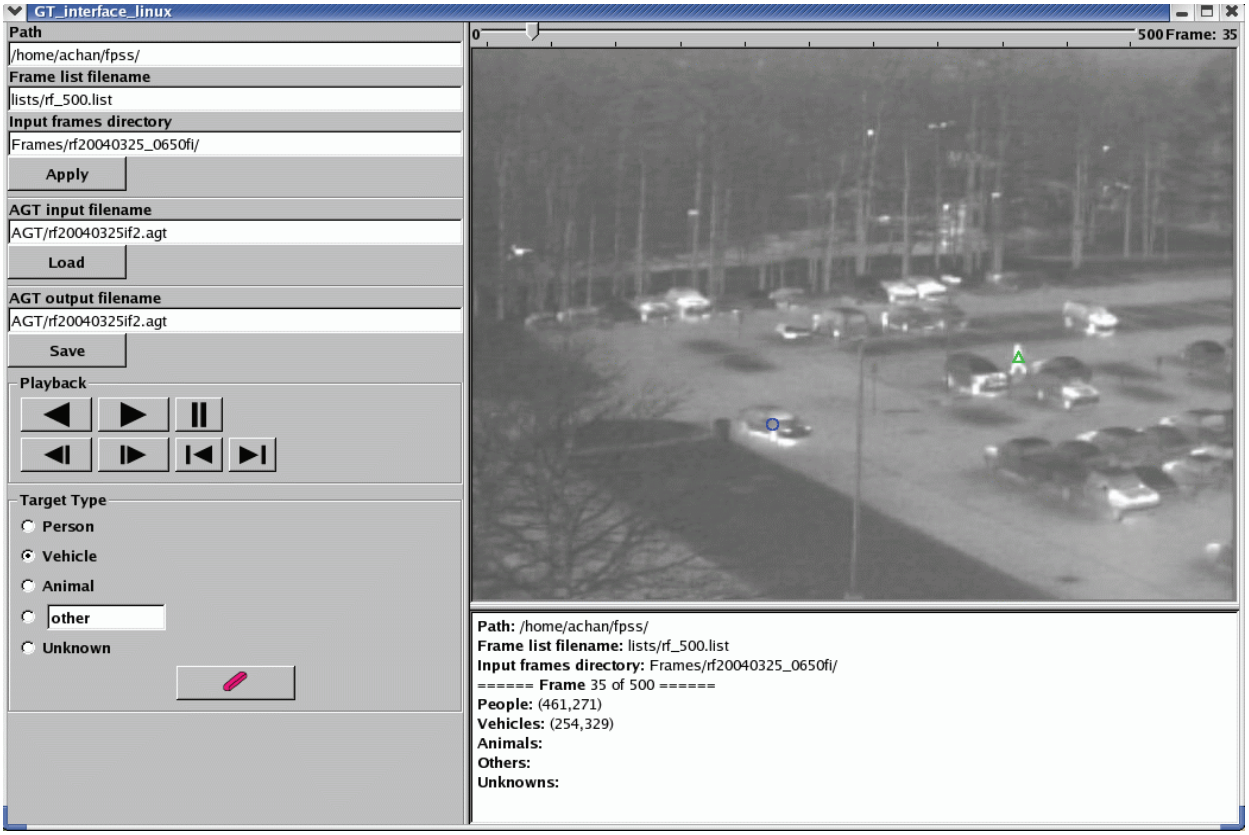

Figure 4. The graphical user interface for our ground-truthing effort.

To use this ground-truthing GUI, one begins by loading and displaying the selected image sequence. This is accomplished by entering appropriate information into the top three text-entering windows and then hitting the "Apply" button. The user may then want to play the whole sequence a few times to become familiarized with all the movements existing in the sequence. Once the user knows where the moving objects are, he or she may start clicking at the center of those moving objects on any frame, while the correct target type at the lower-left corner of the GUI is selected. There are five categories of target type defined in this GUI, namely, "Person," "Vehicle," "Animal," "Unknown," and "Other," which is distinctively represented by a green triangle, a blue circle, an orange square, a red cross, and a purple diamond on the clicked locations on the image. The "Other" category can be specified differently on each frame as necessary, such as lawn-mover, motorcycle, ignored-car, waving-branches, and so forth. The user does not, however, delineate a bounding box or silhouette for any moving object on a frame. There is a trade-off between the extra effort spent and the additional ground-truth information gained. We chose to focus our efforts with a larger dataset, than investing our resources with the tedious ground-truthing process.

The information provided by the user can be saved to or retrieved from an American Standard Code for Information Interchange (ASCII) ground-truth file at any time; hence, allowing the user to stop and restart the ground-truthing process on a given sequence at ease. The resulting

ground-truth information can be easily verified by loading an image sequence and its corresponding ground-truth file into this ground-truthing GUI and playing the sequence end-to-end. The markers will show up on each frame according to the location and target type information provided by the ground-truth file. Any ground-truthing error can be easily recognized if the marker type and/or location do not match the moving objects on any frame. When an error is found, the erroneous marker can be deleted and a correct marker can be inserted with just a few clicks of the mouse. Appendix A provides the ground-truth information pertaining to the first 20 frames of the sequence of rf20041216_144100fc. For each frame, the ground-truth file provides the number of moving targets in each category. If the number of moving targets in a category is not zero, then the corresponding X–Y coordinates of each moving target in that category are provided.

As of July 2006, all 45,121 frames in the First ARL FPSS Dataset and 71,236 frames in the Second ARL FPSS Dataset have been manually ground-truthed and carefully verified using our ground-truthing GUI. These ground-truth files are to be distributed, along with the corresponding ARL FPSS Datasets, to authorized recipients of these datasets.

4. Conclusion

We wrote this brief description to provide a short but accurate overview of the dataset and ground-truth files that we generated for the FPSS project at ARL. Although the datasets are not as extensive and complete as we hope to one day achieve, they are sufficient to enable preliminary development and testing efforts for moving target detection and tracking algorithms. Running the detection and tracking algorithms on a given input sequence and comparing the resulting detections with ground-truth information, allows us to can easily grasp the quantitative performance of these algorithms based on the numbers of target hits and false alarms. Sequences with different cameras, targets, and background characteristics can expose the weaknesses and breakpoints of certain algorithms. Therefore, this dataset can be quite valuable for initial development and testing of detection and tracking algorithms.

For further information on the ARL FPSS Datasets, please contact the author at: U.S. Army Research Laboratory, AMSRD-ARL-SE-SE (Attn: Dr. Alex Chan), 2800 Powder Mill Road, Adelphi, MD 20783, TEL - 301-394-1677, FAX - 301-394-5234, or e-mail achan@arl.army.mil.

Appendix A. Ground-truth Information

Ground-truth information of the first 20 frames in rf20041216_144100fc.agt

```
Frame: 0
People: 2 at x= 103 y= 233 x= 231 y= 217
Vehicles: 0
Animals: 0
Others: 0
Unknowns: 0

Frame: 1
People: 2 at x= 107 y= 234 x= 233 y= 217
Vehicles: 0
Animals: 0
Others: 0
Unknowns: 0

Frame: 2
People: 2 at x= 107 y= 234 x= 236 y= 218
Vehicles: 0
Animals: 0
Others: 0
Unknowns: 0

Frame: 3
People: 2 at x= 106 y= 237 x= 240 y= 218
Vehicles: 0
Animals: 0
Others: 0
Unknowns: 0

Frame: 4
People: 2 at x= 109 y= 235 x= 242 y= 219
Vehicles: 0
Animals: 0
Others: 0
Unknowns: 0

Frame: 5
People: 2 at x= 112 y= 235 x= 245 y= 217
Vehicles: 0
Animals: 0
Others: 0
Unknowns: 0

Frame: 6
People: 2 at x= 114 y= 235 x= 247 y= 217
Vehicles: 0
Animals: 0
Others: 0
Unknowns: 0
```

```
Frame: 7
People: 2 at x= 115 y= 235 x= 249 y= 217
Vehicles: 0
Animals: 0
Others: 0
Unknowns: 0

Frame: 8
People: 2 at x= 117 y= 235 x= 253 y= 218
Vehicles: 0
Animals: 0
Others: 0
Unknowns: 0

Frame: 9
People: 2 at x= 119 y= 235 x= 255 y= 218
Vehicles: 0
Animals: 0
Others: 0
Unknowns: 0

Frame: 10
People: 2 at x= 120 y= 237 x= 259 y= 219
Vehicles: 1 at x= 323 y= 14
Animals: 0
Others: 0
Unknowns: 0

Frame: 11
People: 2 at x= 121 y= 240 x= 260 y= 216
Vehicles: 1 at x= 330 y= 14
Animals: 0
Others: 0
Unknowns: 0

Frame: 12
People: 3 at x= 123 y= 241 x= 263 y= 216 x= 638 y= 479
Vehicles: 1 at x= 333 y= 14
Animals: 0
Others: 0
Unknowns: 0

Frame: 13
People: 3 at x= 127 y= 241 x= 266 y= 214 x= 635 y= 478
Vehicles: 1 at x= 344 y= 11
Animals: 0
Others: 0
Unknowns: 0

Frame: 14
People: 3 at x= 127 y= 241 x= 268 y= 218 x= 633 y= 478
Vehicles: 1 at x= 346 y= 11
Animals: 0
Others: 0
Unknowns: 0
```

```
Frame: 15
People: 3 at x= 129 y= 242 x= 271 y= 217 x= 630 y= 478
Vehicles: 1 at x= 346 y= 11
Animals: 0
Others: 0
Unknowns: 0

Frame: 16
People: 3 at x= 131 y= 242 x= 274 y= 217 x= 628 y= 479
Vehicles: 1 at x= 370 y= 11
Animals: 0
Others: 0
Unknowns: 0

Frame: 17
People: 3 at x= 133 y= 242 x= 277 y= 216 x= 626 y= 477
Vehicles: 1 at x= 374 y= 12
Animals: 0
Others: 0
Unknowns: 0

Frame: 18
People: 3 at x= 135 y= 242 x= 279 y= 216 x= 625 y= 476
Vehicles: 1 at x= 388 y= 9
Animals: 0
Others: 0
Unknowns: 0

Frame: 19
People: 3 at x= 140 y= 242 x= 282 y= 215 x= 623 y= 476
Vehicles: 1 at x= 389 y= 11
Animals: 0
Others: 0
Unknowns: 0

Frame: 20
People: 3 at x= 140 y= 242 x= 285 y= 215 x= 620 y= 475
Vehicles: 1 at x= 389 y= 11
Animals: 0
Others: 0
Unknowns: 0
```

Abbreviations and Acronyms

ALC	Adelphi Laboratory Center
ARL	Army Research Laboratory
ASCII	American Standard Code for Information Interchange
CCD	charge-coupled device
DVR	digital video recorder
FLIR	forward looking infrared
FOV	field-of-view
FPA	focal plane array
FPSS	force protection surveillance system
GUI	graphical user interface
LWIR	long-wave infrared
NTSC	National Television Standards Committee
POD	personnel observation device

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